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FEEDING HABITS OF CALIFORNIA SEA LIONS FROM STRANDED CARCASSES COLLECTED AT SAN DIEGO COUNTY AND SANTA CATALINA ISLAND, CALIFORNIA

By

Mark S. Lowry and Roberta L. Folk

ADMINISTRATIVE REPORT LJ-87-15

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ABSTRACT

We studied the feeding habits of the California sea lion (Zalophus californianus) from identification of stomach contents obtained from stranded carcasses and incidental kills from commercial fisheries and research vessel activities. We collected sagittal fish otoliths, cephalopod beaks, crustacean exoskeletons, and cartilaginous vertebrae to identify prey. The stomach contents from 70 sea lions found in San Diego County, California, from October 1980 through September 1983 included 34 species and 6 genus of prey. Eight types of prey occurred in at least 10% of the stomachs: northern anchovy, Engraulis mordax (34.3%); white croaker, Genyonemus lineatus (30.0%); queenfish, Seriphus politus (24.3%); octopus, Octopus spp. (20.0%); market squid, Loligo opalescens (14.3.%); Pacific whiting, Merluccius productus (14.3%); Pacific mackerel, Scomber japonicus (12.9%); and topsmelt, Atherinops affinis (10.0%). We found age- and sex-specific similarities and differences in the stomach contents of 47 sea lions whose age we had estimated from their canine teeth. The stomach contents of 11 sea lions that had been shot predominantly contained northern anchovy and Pacific whiting. The stomach contents of 11 sea lions stranded at Santa Catalina Island, California, during the winter of 1980, and winter and spring of 1983 included seven species of prey: market squid occurred in 81.8% of the stomachs and the remaining prey occurred in less than 20% of the stomachs.

INTRODUCTION

The California sea lion (Zalophus californianus) is one of the most numerous marine mammals of the western United States. These mammals consume a variety of prey (for a review see Lowry and Oliver, 1986). Some of these prey, such as northern anchovy, Pacific mackerel, and market squid, are taken by commercial or sport fisheries. Feeding habits of California sea lions have been studied at (1) offshore islands in southern California (Antonelis et al., 1984; Lowry and Oliver, 1986; Lowry et al., 1986); (2) the Farallon Islands in central California (Ainley et al., 1977, 1978, 1982; Bailey and Ainley, 1982); (3) the mainland coast of central California (Jones, 1981); (4) the coasts of Oregon and Washington (Roffe and Mate, 1984; and Beach et al., 1985); and (5) Los Islotes, Bay of La Paz, Baja California Sur, Mexico (Aurioles et al., 1984). There have been no studies reported for the feeding habits of sea lions in the northern portion of the Gulf of California, Mexico; the Pacific side of

the Baja California peninsula, Mexico; and the coastal region of southern California. Also, there have been no studies of dietary differences according to age or sex.

In this study we examined the stomach contents of California sea lion carcasses stranded on the mainland of southern California. The deaths of these animals may be attributed to natural causes, disease, gunshot wounds, or incidental kill in commercial fisheries. We estimated the ages of a group of animals from their canine teeth to determine differences in diets according to age; we also examined differences in the sea lions' diet according to sex. We provide information on sea lion carcasses that stranded at Santa Catalina Island and on sea lions that were incidentally killed in commercial fisheries (in one instance, an animal was killed during scientific sampling as part of a research cruise).

MATERIALS and METHODOLOGY

Specimens

The California sea lion specimens we examined were either carcasses that stranded upon the beach, or were animals that had been incidentally killed during fishing operations or incidental to scientific investigations. All specimens were collected from October 1980 through September 1983. Stranded specimens were collected in San Diego County (SDC), California, and at Santa Catalina Island, California. The incidentally killed specimens were collected offshore by government observers aboard commercial fishing vessels or by scientists aboard research vessels.

Freshly dead to very decomposed California sea lion carcasses were examined. Each carcass was assigned a unique specimen number and the following data were recorded for each carcass: (1) collection date; (2) sex; (3) standard length (measured from the tip of the snout to the tip of the tail); (4) estimated loss, if any, in the standard length measurement due to decomposition of the snout or tail (this was added to the measured standard length to derive the total length of the animal); (5) geographical location; (6) presence or absence of gunshot wounds (if it could be determined); and (7) the condition of the carcass (freshly dead, moderately decomposed, undergoing advanced decay, or in mummified or skeletal state). Fresh carcasses were necropsied at the laboratory before being discarded and all others were discarded after being examined in the field.

Stomach Content Analysis

Preliminary examinations of stomachs for food items were completed on-site or during necropsies. Stomachs were collected when food items were present in large quantities. Before 1982, food items were sorted using a 0.710 mm^2 mesh sieve at the laboratory and stored in 70% ethanol until they were examined at a later period. From 1982 until the end of the study in 1983,

the entire stomach was frozen until it could be examined in the laboratory at a later date. Stomachs containing a few food items were discarded during the on-site examination after the food items were stored in a jar or vial containing 70% ethanol. All collected material was labeled with the carcass specimen number. Stomachs without food remains were discarded. Parasites in the stomach were not considered stomach contents.

We rinsed the stomach contents through nested sieves, of which the smallest mesh size was 0.710 mm^2 and the largest was 6.3 mm^2. We did not measure the volume of the stomach contents because postmortem autolysis produced a slurry of bones and flesh in many specimens. Sagittal fish otoliths, cephalopod beaks, crustacean exoskeletons, cartilaginous vertebrae, and other whole animals were collected for identifying prey. The presence of rocks or fishing gear in the stomach was documented.

Identifications were made to species or genus. We labeled prey as unidentified when the remains were too digested to identify the prey to species or genus because of the absence of distinguishing characters. We counted left and right sagittal otoliths, and upper and lower cephalopod beaks. The number of other prey (e.g. crustaceans) items was recorded whenever possible.

We computed percent occurrence for all prey or items (e.g. rocks) and percent minimum number for fish, cephalopods, and other prey whenever possible. Percent occurrence is the percentage of all stomachs with contents which contained remains of a certain item. The computation for percent minimum number is:

For m stomachs in which n prey types occur, the minimum number of the ith prey type is

(1) $$MN_i = \sum_{j=1}^{m} MAX\ (L_{ij}, R_{ij})$$ (i is a fish)

(2) $$MN_i = \sum_{j=1}^{m} MAX\ (U_{ij}, B_{ij})$$ (i is a cephalopod)

(3) $$MN_i = \sum_{j=1}^{m} S_{ij}$$ (i is neither fish nor cephalopod)

where L_{ij} is the number of left fish otoliths; R_{ij} is the number of right fish otoliths; U_{ij} is the number of upper cephalopod beaks; B_{ij} is the number of lower cephalopod beaks; S_{ij} is the number of individual non-fish or non-cephalopods. Then the percent minimum number of prey is:

$$(4) \qquad PMN_i = \frac{MN_i}{\sum_{j=1}^{n} MN_j} \times 100$$

Age Determination

If a sea lion collected in SDC had prey items in its stomach, all canine teeth present on the carcass were collected for age determination. Upper canines were preferred for age determination, but lower canines were used if both upper canines were missing. The canine was cut into two longitudinal sections with an Isomet[1] low-speed saw. Because the saw destroys a section of the tooth that is equal to the thickness of the cutting blade, allowances must be made for this loss prior to sectioning. Therefore, we placed the plane of the saw's cutting blade slightly off center so that at least one of the two longitudinal sections contained the exact, or nearly exact, longitudinal cross section of the pulp cavity. The longitudinal section having the exact, or nearly exact, longitudinal cross section of the pulp cavity was then polished with sharpening stones of various grit under running water to remove grooves produced by the saw during sectioning. The polished section was then etched by immersing it in 10% formic acid for 10 to 25 minutes. The strength of the acid and size of the tooth determined the time it spent in the acid. It was then rinsed with running water and dried. The etched section was placed in acetone for 1 to 2 minutes and then dried. The white deposit produced by the acetone on the etched surface was removed by immersing the section in 70% ethanol for one minute. It was then dried before we examined the layers of dentine. The etching, acetone, and ethanol procedures were repeated if the dentine layers were not evident, but the etching time was reduced to 2-to-5-minute intervals to prevent overetching of the dentine.

Etching produced a series of grooves on the exposed dentine surface, which we used to estimate the age of the animal. These grooves have a pattern of peaks and valleys that are arranged into growth layer groups (GLG)(terminology from Myrick, 1980). We used the GLG count to estimate the age of each animal that had both stomach contents and a canine collected. We calibrated the GLGs from the canines of a 12-year-old captive male sea lion and from carcasses of sea lions originally tagged as pups. We determined that one GLG represented one year of age.

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[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

RESULTS

A total of 249 sea lion carcasses stranded in SDC in various states of decomposition were investigated (Table 1). The stomachs from 108 carcasses were examined for contents (62 were males, 38 females, and 8 were not sexed). We grouped the standard length measurements taken of each carcass into 10 cm class ranges (Figures 1 and 2).

Of the 108 SDC sea lion carcasses that were examined for stomach contents, 70 had food items or other material (e.g. rocks and fishing gear) in their stomach. The condition of the 70 carcasses varied from freshly dead to undergoing advanced decay (Table 1). The majority of these animals were collected during 1981 and 1982 (Table 2). Of the 70 sea lions, 47 were male, 20 were female, and 3 were not sexed. We positively identified 34 prey to species level and 6 prey to genus (Table 3). We found that prey varied from coastal to pelagic species. Eight types of prey occurred in at least 10.0% of the stomachs: northern anchovy, Engraulis mordax (34.3%); white croaker, Genyonemus lineatus (30.0%); queenfish, Seriphus politus (24.3%); octopus, Octopus spp. (20.0%); market squid, Loligo opalescens (14.3%); Pacific whiting, Merluccius productus (14.3%); Pacific mackerel, Scomber japonicus (12.9%); and topsmelt, Atherinops affinis (10.0%). Two types of prey were above 10.0% minimum number: market squid (41.6%) and northern anchovy (20.9%). Rocks were found in the stomachs of 7 sea lions (10.0% occurrence). Monofilament fishing line, with and without fish hooks, was found in the stomachs of 6 sea lions (8.6% occurrence).

It is possible that our complete SDC sample is not representative of sea lions found in coastal areas within the county because some carcasses may have drifted in from outside the county line. The distance covered and time spent drifting by the carcass is probably proportional to the state of decomposition of the stranding. Fresh specimens would be expected to drift a shorter time and a shorter distance, and more decomposed carcasses would presumably have drifted over a longer time and covered more distance.

To determine whether our sample was representative of sea lions found within the county, we examined the food items found in the stomachs of the 16 freshly dead sea lions and 29 moderately decomposed sea lions from SDC (Table 4). Eight types of prey occurred in at least 10.0% of the stomachs of the freshly dead sea lions: northern anchovy (31.3%); Pacific whiting (31.3%); queenfish (25.0%); white croaker (25.0%); market squid (18.8%); octopus (18.8%); basketweave cusk-eel, Ophidion scrippsae (12.5%); and Pacific mackerel (12.5%). Two types of prey were above 10.0% minimum number in the stomachs of freshly dead carcasses: northern anchovy (59.7%) and white surfperch, Phanerodon furcatus (13.5%). Eleven types of prey occurred in at least 10.0% of the stomachs of the moderately decomposed sea lion carcasses: northern anchovy (37.9%); white croaker (34.5%); queenfish (27.6%); octopus (20.7%); Pacific whiting (13.8%);

market squid (13.8%); Pacific mackerel (13.8%); topsmelt, (13.8%); an unidentified shrimp (13.6%); spotted cusk-eel, Chilara taylori (10.3%); and plainfin midshipman, Porichthys notatus (10.3%). Four types of prey were above 10.0% minimum number in the moderately decomposed carcasses: northern anchovy (35.9%), white croaker (13.8%), queenfish (11.6%), and market squid (10.8%). Rocks and monofilament fishing line were found in freshly dead and moderately decomposed sea lion carcasses.

Forty-seven of 62 male sea lions examined from SDC had stomach contents. The majority (55.3%) were in the 110.0 cm to 149.0 cm length-class category, although some animals ranged from 93.0 cm to 231.0 cm (Figure 3). Ten types of prey occurred in at least 10.0% of the stomachs: northern anchovy (38.3%), white croaker (38.3%), queenfish (29.8%), Pacific whiting (21.3%), market squid (17.0%), octopus (21.3%), Pacific mackerel (14.9%), topsmelt (12.8%), basketweave cusk-eel, (10.6%) and shiner surfperch, Cymatogaster aggregata (10.6%) (Table 5). Four types of prey were above 10.0% minimum number: northern anchovy (27.0%), Pacific whiting (19.9%), white croaker (11.2%), and market squid (10.5%). We found rocks in four male sea lions (8.5% occurrence), and monofilament fishing line, with and without fish hooks, in four male sea lions (8.5% occurrence).

Twenty of 38 female sea lions examined from SDC had stomach contents. These animals ranged from 104.6 cm to 177.0 cm in length and were distributed in all length-class categories (Figure 4). Four types of prey occurred in at least 10.0% of the stomachs: northern anchovy (25.0%), octopus (20.0%), white croaker (15.0%), queenfish (15.0%), and unidentified shrimp (15.5%) (Table 5). Two types of prey were above 10.0% minimum number: northern anchovy (49.9%) and white croaker (25.7%). We found rocks in three female sea lions (15.5% occurrence), and monofilament fishing line, with and without fish hooks, in two female sea lions.

We estimated the age from dentinal layers of 47 sea lions from the SDC sample of 70 that had stomach contents for examining age-specific differences in the diet. We found that the sample of sea lions with estimated ages could be divided into two groups for each sex (Table 6). Twenty-one males were two years old or younger, ten males were 6 to 13 years old, nine females were two years old or younger, and seven females were 10 to 13 years old. Because of small sample size, we examined the feeding habits of these four groups instead of by each year-class.

We found age-and sex-specific similarities and differences in the stomach contents of the sea lions with estimated ages (Tables 7 and 8). Two years old or younger sea lions of both sexes consumed many of the same prey. Northern anchovy, white croaker, queenfish, Pacific mackerel, jack mackerel, and Pacific whiting were the predominant prey, both in occurrence and minimum number, in these young sea lions. The male sea lions that were 6 to 13 years of age ate market squid, northern anchovy, and Pacific whiting most often and in greater numbers, and also

several other prey. The 10 to 13 year old female sea lions ate a variety of flatfish, northern anchovy, an unidentified shrimp, squid, and seabass.

Twenty sea lions in the SDC sample of 249 had gunshot wounds. The remaining 229 sea lions either did not have gunshot wounds or were too decomposed to determine if gunshot wounds were present. Fourteen of the 20 sea lions with gunshot wounds, which were from 116.9 cm to 231.0 cm long, had contents in their stomachs (Figure 5). Half of these animals were freshly dead (Table 1). Thirteen were male and one was a female. The stomachs of the thirteen male sea lions that were shot predominantly contained northern anchovy and Pacific whiting (Table 9). These stomachs also contained Pacific mackerel and white croaker in addition to other prey species. One contained the remains of two Pacific bonito (Sarda chiliensis). Two contained monofilament fishing line with fish hooks. The stomach of one female sea lion with gunshot wounds contained northern anchovy, white croaker, rockfish, the squid Onychoteuthis borealijaponicus, and an unidentified surfperch.

We also examined the stomachs of 11 sea lion carcasses (3 males and 8 females) found at Santa Catalina Island, California. In December 1980, the stomach from one male was collected. In 1983, stomachs were collected from one female in January, from one male and six females in February, and from one male and one female in March. The stomachs contained market squid, Pacific sanddab (Citharichthys sordidus), speckled sanddab (C. stigmaeus), northern anchovy, octopus, an unidentified cepahalopod, and an unidentified flatfish (Table 10). Market squid occurred in 81.8% of the samples and represented 97.7% of the minimum number of prey. The remaining prey items were below 20.0% occurrence and below 2% minimum number. There were no gross differences between the stomach contents of males and females. Nine of these sea lions had gunshot wounds.

We examined the stomach contents of 7 sea lions (4 males and 3 females) that were incidentally killed in a fishery or by researchers at different locations on 4 dates (Table 11). The stomachs of these sea lions contained northern anchovy, market squid, octopus, night smelt (Spirinchus starksi), jacksmelt (Atherinopsis californiensis), Pacific herring (Clupea pallissi), Pacific mackerel, jack mackerel (Trachurus symmetricus), Pacific whiting, medusafish (Icichthys lockingtoni), pelagic red crab (Pleuroncodes planipes), and an unidentified fish (Table 12).

DISCUSSION

Analysis of scats (fecal material) from California sea lions is the most common method used today for studying their feeding habits (Antonelis, et al. 1984; Aurioles et al. 1984; Lowry and Oliver, 1986; and Lowry et al., 1986). Although it is relatively easy to collect scats from the rookeries located on offshore islands, it is not possible to use scat analysis for studying the

feeding habits of sea lions found in waters near the mainland because the animals predominantly haul out in small numbers on jetties, bouys, and offshore rocks that are not readily accessible to researchers. Analysis of stomach contents from carcasses found on the beaches of the mainland is an alternative method of studying their feeding habits if we assume that stomach contents are representative of prey eaten by these animals.

The possibility exists, however, that prey of stranded animals may not reflect feeding behavior of healthy animals. If the animal was ill before it died, then its last meal may not be representative of the diet of healthy animals. It may be assumed, however, that a certain proportion of the population is always ill, and this represents the diet for a fraction of the population. Also, sea lions that had empty stomachs may represent an unknown proportion of sea lions that are in poor health and are not eating.

A statistical analysis of northern fur seal stomach contents by Perez (1984) suggests that a sample size of greater than 50 is needed to assess the feeding habits of a pinniped for a given region or time period. Our total sample size of 70 SDC sea lions exceeds this minimum, but we feel that the 3-year period covered by these samples is too long to assess their feeding habits accurately. Lowry and Oliver (1986) and Lowry et al. (1986) found seasonal and yearly differences in the diet of sea lions at San Clemente Island, California. Because SDC is near San Clemente Island, we would expect that seasonal and yearly differences would bias our conclusions. Furthermore, the sample size for each age and sex class studied is too small to asses accurately the feeding habits of animals in these categories. The sample size of the animals from Santa Catalina Island and the incidental kills are also small. However, results of our study are useful because they identify the variety of prey being consumed by sea lions along the mainland coast of southern California and northern Baja California, Mexico, at Santa Catalina Island, and other areas.

Results from our stomach content analysis of freshly dead sea lions and moderately decomposed sea lions which stranded in SDC indicated that these animals preyed upon a variety of species found in various habitats. A few examples include: (1) pelagic species such as northern anchovy, Pacific whiting, and Pacific mackerel; (2) inshore species such as white croaker, queenfish, topsmelt, and various species of surfperch; (3) bottom dwelling species such as Pacific sanddab, rex sole, dover sole, basketweave cusk-eel, and spotted cusk-eel. These prey and others identified most likely reflect prey being eaten by sea lions along the coastlines of SDC, Orange County, and Northern Baja California, Mexico. The prey items found in the freshly dead sea lions probably reflect the diet of sea lions found in waters just off SDC. The prey items found in the moderately decomposed sea lion carcasses may reflect the feeding habits of the sea lions inhabiting the coastal waters off Orange County, SDC and Northern Baja California, Mexico.

The 14 sea lions with gunshot wounds and contents in their stomach probably received their wounds as a consequence of interacting with a fishery. The stomach of one sea lion that was shot contained fishing gear (monofilament fishing line) and slightly digested bonito in the stomach. Bonito is commonly fished by sport and commercial fishermen. The 6 sea lions found with monofilament fishing line (some with fish hooks tied onto it) may have been shot when they interfered with a sportfishermen, or they may have consumed a fish that had a piece of fishing gear attached to it after it escaped from a sportfisherman. We do not, however, have proof of this interaction.

Although we do not know why rocks were found in the stomachs of some of the sea lions we examined, we can offer several reasons why they were eaten: (1) accidental consumption while foraging on the bottom; (2) to give the animal a feeling of a full stomach if it is having trouble foraging for its natural food; (3) as a mechanical means to aid digestion or to control parasite loads; (4) mineral supplement in their diet; or (5) buoyancy control during swimming.

We found that there were differences and similarities in the diets of sea lions stranded in SDC and the diets of sea lions found offshore. We compared the stomach contents of carcasses found in SDC to: (1) the stomach contents from sea lions collected offshore; and (2) results of the sea lion feeding habits study made from scat analysis at San Clemente Island (Lowry and Oliver, 1986; and Lowry et al., 1986). The San Clemente Island study was chosen because the studies there were made at approximately the same time as ours (September 1981 through September 1985 at San Clemente Island and October 1980 through September 1983 at SDC) and because San Clemente Island is near SDC (they are approximately 55 nautical miles apart). The stomachs of sea lions found near islands and sea lion scats collected at San Clemente Island do not contain coastal varieties of prey, such as white croaker and queenfish, which are commonly found in many of the SDC sea lion specimens. The prey items identified in the stomachs of the sea lions from Santa Catalina, Santa Cruz, and Santa Barbara islands are commonly found in the diet of the San Clemente Island sea lions. Prey that are common to the diet of sea lions found stranded on mainland beaches in SDC and of sea lions found near islands include northern anchovy, Pacific whiting, Pacific mackerel, and market squid.

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Table 1. Comparison of carcass condition for California sea lions stranded in San Diego County, California, from October 1980 through September 1983.

Carcass Condition	All Specimens Investigated			Specimens W/ Stomach Examination			Specimens With Stomach Contents								
							All Specimens			Juveniles		Sub-Adults & Adults		W/ Gunshot Wounds	
Sex:	M	F	?	M	F	?	M	F	?	M	F	M	F	M	F
Freshly dead	23	13		17	7		15	1		6		2	1	7	
Moderately decomposed	51	31	3	26	16		19	10		12	5	4	3	6	
Advanced decay	67	33	21	19	15	8	13	9	3	3	4	4	3		1
Mummified or skeletal remains	1		5												
Unknown	1														
Total:	143	77	29	62	38	8	47	20	3	21	9	10	7	13	1

Table 2. Number of California sea lion carcasses examined in San Diego County, California, with stomach contents from 1980 through 1983. (? = sex unknown)

Month	1980		1981			1982		1983		
	Male	Female	Male	Female	?	Male	Female	Male	Female	?
January							1		1	
February			1			1	1			
March			3			1	1			1
April			1			1				
May			4	1		4				
June			1	2		7	4			
July					1	3	1			
August			3			1		1		
September			4	1				1	1	
October	1		4	3	1					
November			1	1			1			
December	1		1	1		2				
YEAR TOTAL:	2		23	9	2	20	9	2	2	1

Table 3. Occurrence and minimum number of individual prey found in stomachs of 70 beached California sea lion carcasses found in San Diego County, California, from October 1980 through September 1983.

Scientific name	Common name	Occurrence n stom	Occurrence %	Minimum number n ind	Minimum number %
Engraulis mordax	northern anchovy	25	34.3	546	20.8
Genyonemus lineatus	white croaker	21	30.0	246	9.4
Seriphus politus	queenfish	17	24.3	117	4.4
Octopus spp.	octopus	14	20.0	37	1.4
Loligo opalescens	market squid	10	14.3	1084	41.2
Merluccius productus	Pacific whiting	10	14.3	257	9.8
Scomber japonicus	Pacific mackerel	9	12.9	20	0.8
Atherinops affinis	topsmelt	7	10.0	16	0.6
Cymatogaster aggregata	shiner surfperch	6	8.6	10	<0.5
Sebastes spp.	rockfish	6	8.6	24	0.9
Chilara taylori	spotted cusk-eel	6	8.6	6	<0.5
Ophidion scrippsae	basketweave cusk-eel	5	7.1	68	2.6
Porichthys notatus	plainfin midshipman	5	7.1	9	<0.5
Trachurus symmetricus	jack mackerel	4	5.7	22	<0.5
Chromis punctipinnis	blacksmith	4	5.7	32	1.2
Phanerodon furcatus	white surfperch	4	5.7	52	2.0
Peprilus simillimus	Pacific butterfish	4	5.7	8	<0.5
Gonatus spp.	squid	3	4.3	7	<0.5
Sarda chiliensis	Pacific bonito	2	2.9	3	<0.5
Citharichthys sordidus	Pacific sanddab	2	2.9	3	<0.5
Parophrys vetulus	English sole	2	2.9	6	<0.5
Zaniolepis spp.	combfish	2	2.9	2	<0.5
Microstomus pacificus	dover sole	1	1.4	4	<0.5
Symphurus atricauda	California tonguefish	1	1.4	2	<0.5
Citharichthys stigmaeus	speckled sanddab	1	1.4	1	<0.5
Glyptocehalus zachirus	rex sole	1	1.4	1	<0.5
Citharichthys sp.	sanddab	1	1.4	1	<0.5
Damalichthys vacca	pile surfperch	1	1.4	1	<0.5
Rhacochilus toxotes	rubberlip surfperch	1	1.4	1	<0.5
Zalembius rosaceus	pink surfperch	1	1.4	2	<0.5
Leuresthes tenuis	California grunion	1	1.4	-	-
Cheilotrema saturnum	black croaker	1	1.4	1	<0.5
Paralabrax sp.	sea bass	1	1.4	1	<0.5
Oxyjulis californica	senorita	1	1.4	1	<0.5
Lycodopsis pacificus	blackbelly eelpout	1	1.4	1	<0.5
Porichthys myriaster	specklefin midshipman	1	1.4	1	<0.5
Synodus lucioceps	California lizardfish	1	1.4	1	<0.5
Pleuroncodes planipes	pelagic red crab	1	1.4	-	-
Onychoteuthis borealijaponicus	squid	1	1.4	1	<0.5
Abraliopsis felis	squid	1	1.4	1	<0.5

columns marked by a dash (-) are not computable
n stom = number of stomachs where the item occurred
n ind = number of individual prey

Table 3. (cont.'d)

Scientific name	Common name	Occurrence n stom	Occurrence %	Minimum number n ind	Minimum number %
unidentified Embiotocidae	surfperch	4	5.7	7	<0.5
unidentified Scianidae	croaker	3	4.3	3	<0.5
unidentified Gonatidae	squid	1	1.4	1	<0.5
unidentified Myctophidae	lanternfish	1	1.4	1	<0.5
unidentified Atherinidae	silverside	1	1.4	1	<0.5
unidentified Scombridae	mackerel	1	1.4	1	<0.5
unidentified cartilaginous fish		2	2.9	-	-
unidentified ray	skate or ray	1	1.4	1	<0.5
	unid. shrimp fragments	5	7.1	2	<0.5
	unid. flatfish	2	2.9	2	<0.5
	unid. cephalopod	1	1.4	1	<0.5
	hermit crab	1	1.6	1	<0.5
	unid. crab	1	1.4	-	-
	unid. limpet	1	1.4	2	<0.5
	Small bivalve	1	1.6	-	-
	unid. fishes	14	20.0	10	<0.5
unidentified otolith fragments		9	12.9	-	-
unidentified lapillus or asteriscus otoliths		13	18.6	-	-
OTHER:					
unidentified vegetative fragments		1	1.4		
rocks		7	10.0	-	-
monofilament line with and without fish hooks		6	8.6	-	-

columns marked by a dash (-) are not computable
n stom = number of stomachs where the item occurred
n ind = number of individual prey

Table 4. Occurrence and minimum number of individual prey found in the stomachs of 16 freshly dead and 29 moderately decomposed California sea lion carcasses that were stranded in San Diego County, California, from October 1980 through September 1983.

Prey	Freshly dead carcasses				Moderately decomposed carcasses			
	Occurrence		Minimum number		Occurrence		Minimum number	
	n stom	%	n ind	%	n stom	%	n ind	%
Engraulis mordax	5	31.3	212	59.7	11	37.9	250	35.9
Merluccius productus	5	31.3	17	4.8	4	13.8	49	7.0
Seriphus politus	4	25.0	10	2.8	8	27.6	81	11.6
Genyonemus lineatus	4	25.0	8	2.3	10	34.5	96	13.8
Loligo opalescens	3	18.8	6	1.7	4	13.8	75	10.8
Octopus spp.	3	18.8	4	1.1	6	20.7	23	3.3
Ophidion scrippsae	2	12.5	14	3.9	1	3.4	25	3.6
Scomber japonicus	2	12.5	7	2.0	4	13.8	10	1.4
Phanerodon furcatus	1	6.3	48	13.5	1	3.4	1	<0.5
Parophrys vetulus	1	6.3	5	1.4				
Microstomus pacificus	1	6.3	4	1.1				
Chromis punctipinnis	1	6.3	3	0.8	2	6.9	11	1.6
Atherinops affinis	1	6.3	1	<0.5	4	13.8	6	0.9
Cymatogaster aggregata	1	6.3	1	<0.5	2	6.9	3	<0.5
Sebastes spp.					2	6.9	19	2.7
Chilara taylori	1	6.3	1	<0.5	3	10.3	3	<0.5
Porichthys notatus					3	10.3	3	<0.3
Trachurus symmetricus					2	6.9	4	0.6
Peprilus simillimus	1	6.3	1	<0.5	1	3.4	5	0.7
Sarda chiliensis	1	6.3	2	0.6				
Zaniolepis spp.	1	6.3	1	<0.5				
Citharichthys sordidus	1	6.3	1	<0.5	1	3.4	2	<0.5
Citharichthys stigmaeus					1	3.4	1	<0.5
Glyptocehalus zachirus	1	6.3	1	<0.5				
Citharichthys sp.	1	6.3	1	<0.5				
Symphurus atricauda					1	3.4	2	<0.5
Zalembius rosaceus					1	3.4	2	<0.5

columns marked by a dash [-] are not computable
n stom = number of stomachs where the item occurred
n ind = number of individuals

Table 4. (Continued)

Prey	Freshly dead carcasses: Occurrence n stom	Freshly dead carcasses: Occurrence %	Freshly dead carcasses: Minimum number n ind	Freshly dead carcasses: Minimum number %	Moderately decomposed carcasses: Occurrence n stom	Moderately decomposed carcasses: Occurrence %	Moderately decomposed carcasses: Minimum number n ind	Moderately decomposed carcasses: Minimum number %
Rhacochilus toxotes					1	3.4	1	<0.5
Damalichthys vacca					1	3.4	1	<0.5
Leuresthes tenuis					1	3.4	1	<0.5
Cheilotrema saturnum					1	3.4	1	<0.5
Paralabrax sp.	1	6.3	1	<0.5				
Oxyjulis californica					1	3.4	1	<0.5
Lycodopsis pacificus	1	6.3	1	<0.5				
Synodus lucioceps					1	3.4	1	<0.5
Porichthys myriaster					1	3.4	-	-
Pleuroncodes planipes					1	3.4	3	<0.5
Gonatus spp.					1	3.4	2	<0.5
unidentified Embiotocidae	1	6.3	1	<0.5	1	3.4	1	<0.5
unidentified Scianidae	1	6.3	-	-	1	3.4	-	-
unidentified cartilaginous fish	1	6.3	1	<0.5	1	3.4	1	<0.5
unidentified flatfish	1	6.3	1	<0.5	4	13.8	2	<0.5
unidentified shrimp					1	3.4	1	<0.5
unidentified cephalopod								
Hermit Crab	1	6.3	1	<0.5				
unidentified small bivalve	1	6.3	-	-				
unidentified limpet					1	3.4	2	<0.5
unidentified fishes	1	6.3	1	<0.5	7	24.1	7	1.0
unidentified otolith fragments	3	18.8	-	-	4	13.8	-	-
unidentified lapillus or asteriscus otoliths	1	6.3	-	-	5	17.2	-	-
OTHER:								
unidentified vegetative fragments	1	6.3	-	-				
rocks	2	12.5	-	-	3	10.3	-	-
monofilament line with and without fish hooks	2	12.5	-	-	4	13.8	-	-

columns marked by a dash [-] are not computable
n stom = number of stomachs where the item occurred
n ind = number of individuals

Table 5. Occurrence and minimum number of individual prey found in the stomachs of 47 male and 20 female California sea lion carcasses that were stranded in San Diego County, California, from October 1980 through September 1983.

Prey	Males				Females			
	Occurrence		Minimum number		Occurrence		Minimum number	
	n stom	%	n ind	%	n stom	%	n ind	%
Engraulis mordax	18	38.3	348	27.0	5	25.0	196	49.9
Genyonemus lineatus	18	38.3	154	11.2	3	15.0	101	25.7
Seriphus politus	14	29.8	82	6.4	3	15.0	35	8.9
Merluccius productus	10	21.3	257	19.9				
Octopus spp.	10	21.3	28	2.2	4	20.0	8	2.0
Loligo opalescens	8	17.0	136	10.5	1	5.0	3	0.8
Scomber japonicus	7	14.9	17	1.3	2	10.0	3	0.8
Atherinops affinis	6	12.8	8	0.6	1	5.0	8	2.0
Ophidion scrippsae	5	10.6	68	5.3				
Cymatogaster aggregata	5	10.6	7	0.5	1	5.0	3	0.8
Sebastes spp.	4	8.5	21	1.6	2	10.0	3	0.8
Phanerodon furcatus	4	8.5	52	4.0				
Chilara taylori	4	8.5	4	<0.5	2	10.0	1	<0.5
Porichthys notatus	4	8.5	8	0.6	1	5.0	1	<0.5
Trachurus symmetricus	3	6.4	21	1.6	1	5.0	1	<0.5
Chromis punctipinnis	3	6.4	31	2.4	1	5.0	1	<0.5
Peprilus simillimus	3	6.4	7	0.5	1	5.0	1	<0.5
Sarda chiliensis	2	4.3	3	<0.5				
Zaniolepis spp.	2	4.3	2	<0.5				
Microstomus pacificus	1	2.1	4	<0.5				
Citharichthys sordidus	1	2.1	2	<0.5	1	5.0	1	<0.5
Parophrys vetulus	1	2.1	1	<0.5	1	5.0	5	1.3
Citharichthys stigmaeus					1	5.0	1	<0.5
Glyptocephalus zachirus	1	2.1	1	<0.5				
Citharichthys sp.					1	5.0	1	<0.5
Symphurus atricauda					1	5.0	2	0.5
Zalembius rosaceus	1	2.1	2	<0.5				
Rhacochilus toxotes	1	2.1	1	<0.5				
Damalichthys vacca	1	2.1	1	<0.5				
Leuresthes tenuis					1	5.0	1	<0.5
Cheilotrema saturnum	1	2.1	1	<0.5				
Paralabrax sp.					1	5.0	1	<0.5

columns marked by a dash [-] are not computable
n stom = number of stomachs where the item occurred
n ind = number of individuals

Table 5. (Continued)

Prey	Males				Females			
	Occurrence		Minimum number		Occurrence		Minimum number	
	n stom	%	n ind	%	n stom	%	n ind	%
Oxyjulis californica	1	2.1	1	<0.5				
Lycodopsis pacificus	1	2.1	1	<0.5				
Synodus lucioceps	1	2.1	1	<0.5				
Porichthys myriaster	1	2.1	1	<0.5				
Pleuroncodes planipes	1	2.1	-	-				
Abraliopsis felis	1	2.1	1	<0.5				
Onychoteuthis borealijaponicus					1	5.0	1	<0.5
Gonatus spp.	1	2.1	1	<0.5	2	10.0	6	1.5
unidentified Embiotocidae	3	6.4	6	0.5	1	5.0	1	<0.5
unidentified Scianidae	2	4.3	2	<0.5	1	5.0	1	<0.5
unidentified Gonatidae	1	2.1	1	<0.5				
unidentified Myctophidae	1	2.1	1	<0.5				
unidentified Atherinidae	1	2.1	1	<0.5				
unidentified Scombridae	1	2.1	1	<0.5				
unidentified ray					1	5.0	-	-
unidentified cartilaginous fish	1	2.1	-	-	1	5.0	-	-
unidentified flatfish	1	2.1	1	<0.5	1	5.0	1	<0.5
unidentified shrimp	2	4.3	2	<0.5	3	15.0	-	-
unidentified cephalopod	1	2.1	1	<0.5				
unidentified crab	1	2.1	-	-				
Hermit Crab	1	2.1	1	<0.5				
unidentified small bivalve	1	2.1	-	-				
unidentified limpet	1	2.1	2	<0.5				
unidentified fishes	8	17.0	6	0.5	4	20.0	4	1.0
unidentified otolith fragments	7	14.9	-	-	2	10.0	-	-
unidentified lapillus or asteriscus otoliths	10	21.3	-	-	3	15.5	-	-
OTHER:								
unidentified vegetative fragments	1	2.1	-	-				
rocks	4	8.5	-	-	3	14.3	-	-
monofilament line with and without fish hooks	4	8.5	-	-	2	10.0	-	-

columns marked by a dash [-] are not computable
n stom = number of stomachs where the item occurred
n ind = number of individuals

Table 6. Number of California sea lion carcass strandings from San Diego County, California with stomach contents arranged by estimated age.

Estimated age (yr)	Male	Female
<1	6	2
1	9	4
2	6	3
3		
4		
5		
6	3	
7	1	
8	1	
9	1	
10	1	1
11	1	2
12	1	2
13	1	2
unknown	16	4

Table 7. Occurrence and minimum number of individual prey found in stomachs of carcasses from <1-2 year old California sea lions found in San Diego County, California.

Prey	Males <1-2 yrs. (Estimated) (N = 21) Occurrence n stom	%	Minimum number n ind	%	Females <1-2 yrs. (Estimated) (N = 9) Occurrence n stom	%	Minimum number n ind	%
Engraulis mordax	10	47.6	240	51.3	3	33.3	183	51.5
Genyonemus lineatus	9	42.9	82	17.5	3	33.3	101	28.5
Seriphus politus	6	28.6	34	7.3	3	33.3	35	39.9
Scomber japonicus	6	28.6	11	2.4	1	11.1	2	0.6
Merluccius productus	5	23.8	40	8.5				
Atherinops affinis	4	19.0	6	1.3	1	11.1	8	2.3
Octopus sp.	4	19.0	4	0.9	3	33.3	4	1.1
Trachurus symmetricus	3	14.3	21	4.5	1	11.1	1	<0.5
Peprilus simillimus	3	14.3	7	1.5	1	11.1	1	<0.5
Chilara taylori	2	9.5	2	<0.5	2	22.2	2	0.6
Cymatogaster aggregata	2	9.5	2	<0.5	1	11.1	3	0.8
Porichthys notatus	2	9.5	2	<0.5	1	11.1	1	<0.5
Loligo opalescens	1	4.8	3	0.6				
Phanerodon furcatus	1	4.8	1	<0.5				
Parophrys vetulus	1	4.8	1	<0.5				
Synodus lucioceps	1	4.8	1	<0.5				
Damalichthys vacca	1	4.8	1	<0.5				
Sebastes spp.					2	22.2	3	0.8
Chromis punctipinnis					1	11.1	1	<0.5
Onychoteuthis borealijaponicus					1	11.1	1	<0.5
Citharichthys stigmaeus					1	11.1	1	<0.5
Leuresthes tenuis					1	11.1	1	<0.5
Symphurus atricauda					1	11.1	2	0.6
Porichthys myriaster	1	4.8	1	<0.5				
unidentified Scianidae	1	4.8	1	<0.5	1	11.1	1	<0.5
unidentified Atherinidae	1	4.8	1	<0.5				
unidentified Embiotocidae	1	4.8	3	0.6	1	11.1	1	<0.5
unidentified fish	1	4.8	-	-	2	22.2	2	0.6
unidentified shrimp	2	9.5	2	<0.5				
unidentified limpets	1	4.8	2	0.8				
unidentified lapillus or asteriscus otoliths	2	9.5	-	<0.5	3	33.3	-	-
unidentified otolith fragments	4	19.0	-	-	1	11.1	-	-
OTHER:								
rocks	2	9.5	-	-	1	11.1	-	-
unid. vegetative fragments	1	4.8	-	-				

n stom = number of stomachs where the item occurred
n ind = minimum number of individuals
Column marked by a dash [-] are not computable

Table 8. Occurrence and minimum number of individual prey found in stomachs of subadult and adult males, and adult female California sea lion carcasses collected from San Diego County, California.

Prey	Males 6 to 13 yrs. old (Estimated) (N = 10) Occurrence n stom	%	Minimum number n ind	%	Females 10 to 15 yrs old (Estimated) (N = 7) Occurrence n stom	%	Minimum number n ind	%
Loligo opalescens	4	40.0	129	24.7				
Engraulis mordax	4	40.0	83	16.3	1	14.3	2	11.1
Merluccius productus	3	30.0	212	40.5				
Octopus sp.	3	30.0	6	1.1				
Sebastes spp.	3	30.0	4	0.8				
Ophidion scrippsae	2	20.0	32	6.1				
Genyonemus lineatus	2	20.0	10	1.9				
Porichthys notatus	2	20.0	6	1.1				
Zaniolepis spp.	2	20.0	2	<0.5				
Chromis punctipinnis	1	10.0	10	1.9				
Scomber japonicus	1	10.0	6	1.1				
Microstomus pacificus	1	10.0	4	0.8				
Sarda chiliensis	1	10.0	2	<0.5				
Citharichthys sordidus	1	10.0	2	<0.5	1	14.3	1	5.6
Seriphus politus	1	10.0	1	<0.5				
Gonatus spp.	1	10.0	1	<0.5	1	14.3	3	16.7
Cheilotrema saturnum	1	10.0	1	<0.5				
Oxyjulis californica	1	10.0	1	<0.5				
Glyptocephalus zachirus	1	10.0	1	<0.5				
Lycodopsis pacifica	1	10.0	1	<0.5				
Pleuroncodes planipes	1	10.0	-	-				
Abraliopsis felis	1	10.0	1	<0.5				
Parophrys vetulus					1	14.3	5	27.8
Citharichthys sp.					1	14.3	1	5.6
Paralabrax sp.					1	14.3	1	5.6

n stom = number of stomachs where the item occurred
n ind = minimum number of individuals
columns marked by a dash [-] are not computable

Table 8. (Continued)

Prey	Males 6 to 13 yrs. old (Estimated) (N = 10) Occurrence n stom	%	Minimum number n ind	%	Females 10 to 15 yrs old (Estimated) (N = 7) Occurrence n stom	%	Minimum number n ind	%
unidentified Gonatidae	1	10.0	1					
unidentified Myctophidae	1	10.0	1	<0.5				
unidentified flatfish	1	10.0	1	<0.5	1	14.3	1	5.6
unidentified fish	3	30.0	2	<0.5				
unidentified ray	1	10.0	-	-				
unidentified cartilaginous fish	1	10.0	-	-				
unidentified cephalopod	1	10.0	1	<0.5				
unidentified crab	1	10.0	1	<0.5				
unidentified shrimp					2	28.6	-	-
unidentified otolith fragments					1	14.3	-	-
unidentified lapillus or asteriscus otoliths	3	30.0	-	-				
OTHER:								
monofilament line with and without hooks	2	20.0	-	-				
rocks					1	14.3	-	-

n stom = number of stomachs where the item occurred
n ind = minimum number of individuals
columns marked by a dash [-] are not computable

Table 9. Occurrence and minimum number of individual prey found in stomachs of stranded California sea lion carcasses with gunshot wounds that were collected in San Diego County, California.

Prey	Males (N = 13) Occurrence n stom	%	Minimum Number n ind	%	Females (N = 1) present ?	Minimum Number n ind
Engraulis mordax	7	53.8	259	59.3	present	8
Merluccius productus	7	53.8	62	14.2		
Scomber japonicus	3	23.1	8	1.8		
Genyonemus lineatus	3	23.8	6	1.4	present	61
Octopus spp.	2	15.4	3	0.7		
Porichthys notatus	2	15.4	2	0.5		
Phanerodon furcatus	1	7.7	48	11.0		
Ophidion scrippsae	1	7.7	25	5.7		
Loligo opalescens	1	7.7	2	0.5		
Sarda chiliensis	1	7.7	2	0.5		
Sebastes spp.	1	7.7	2	0.5	present	1
Microstomus pacificus	1	7.7	4	0.9		
Citharichthys sordidus	1	7.7	2	0.5		
Glyptocephalus zachirus	1	7.7	1	<0.5		
Seriphus politus	1	7.7	1	<0.5		
Atherinops affinis	1	7.7	1	<0.5		
Porichthys myriaster	1	7.7	1	<0.5		
Zaniolepis sp.	1	7.7	1	<0.5		
Synodus lucioceps	1	7.7	1	<0.5		
Onychoteuthis borealijaponicus					present	1
Pleuroncodes planipes	1	7.7	-	-		
unidentified Embiotocidae					present	1
unidentified flatfish	1	7.7	1	<0.5		
unidentified fish	4	30.8	2	0.5		
unidentified shrimp	1	7.7	2	0.5		
unidentified cephalopod	1	7.7	1	<0.5		
unidentified cartilaginous fish	1	7.7	-	-		
monofilament with fish hooks	2	15.4	-	-		

n stom = number of stomachs where the item occurred
n ind = minimum number of individuals
columns marked by a dash [-] are not computable

Table 10. Occurrence and minimum number of prey individuals found in stomachs of California sea lion carcasses found at Santa Catalina Island, California, in 1980 and 1983.

Prey	All specimens (N = 11)				Males (N = 3)				Females (N = 8)			
	Occurrence		Minimum number		Occurrence		Minimum number		Occurrence		Minimum number	
	n stom	%	n ind	%	n stom	%	n ind	%	n stom	%	n ind	%
Loligo opalescens	9	81.8	955	97.7	3	100.0	268	97.7	6	75.0	687	97.6
Citharichthys sordidus	2	18.2	4	0.4	1	33.3	3	1.1	1	12.5	1	<0.5
Engraulis mordax	1	9.1	15	1.5					1	12.5	15	2.1
Octopus spp.	1	9.1	2	<0.5	1	33.3	2	0.7				
Citharichthys stigmaeus	1	9.1	1	<0.5	1	33.3	1	<0.5				
unidentified cephalopod	1	9.1	1	<0.5					1	12.5	1	<0.5
unidentified flatfish	1	9.1	1	<0.5	1	33.3	1	<0.5				
rocks	1	9.1	-	-					1	12.5	-	-

n stom = number of stomachs where the item occurred
n ind = minimum number of individuals

Table 11. California sea lions that had stomach contents and that had been incidentally killed in a fishery.

Location of capture	Sex Male (n)	Sex Female (n)	Capture date Month	Capture date Year	Type of interaction
9.5 nautical miles N.E. of Santa Barbara Island		1	February	1980	Captured in anchovy trawl during survey
~5 miles west of San Clemente, California	1		May	1980	Captured in halibut trammel net
Salinas River State Beach, California	1		June	1981	Captured in a gillnet
8 miles south of Santa Cruz Island	2	2	July	1982	Caught in drift gillnet

Table 12. Occurrence and minimum number of prey found in stomachs of California sea lions incidentally killed near Santa Cruz Island; Salinas River State Beach; San Clemente, California; and Santa Barbara Island.

Prey	* Santa Cruz Island (N = 4)		Salinas River State Beach (N = 1)		** San Clemente, California (N = 1)		Santa Barbara Island (N = 1)	
	Occ %	Min # %	Occ %	Min # %	Occ %	Min # %	Occ %	Min # %
Merluccius productus	50.0	20.5						
Engraulis mordax			100	11.6	100	100	100	100
Trachurus symmetricus	50.0	25.6						
Scomber japonicus	50.0	51.3						
Loligo opalescens			100	82.0				
Octopus sp.			100	1.6				
Icichthys lockingtoni	25.0	2.6						
Pleuroncodes planipes	25.0	-						
Spirinchus starksi			100	1.6				
Atherinopsis californiensis			100	1.6				
Clupea pallissi			100	1.6				
unidentified fish	25.0							

* 8 miles south
** ~5 miles west of pier
columns marked by a dash (-) are not computable
Occ = percent occurrence
Min # = percent minimum number

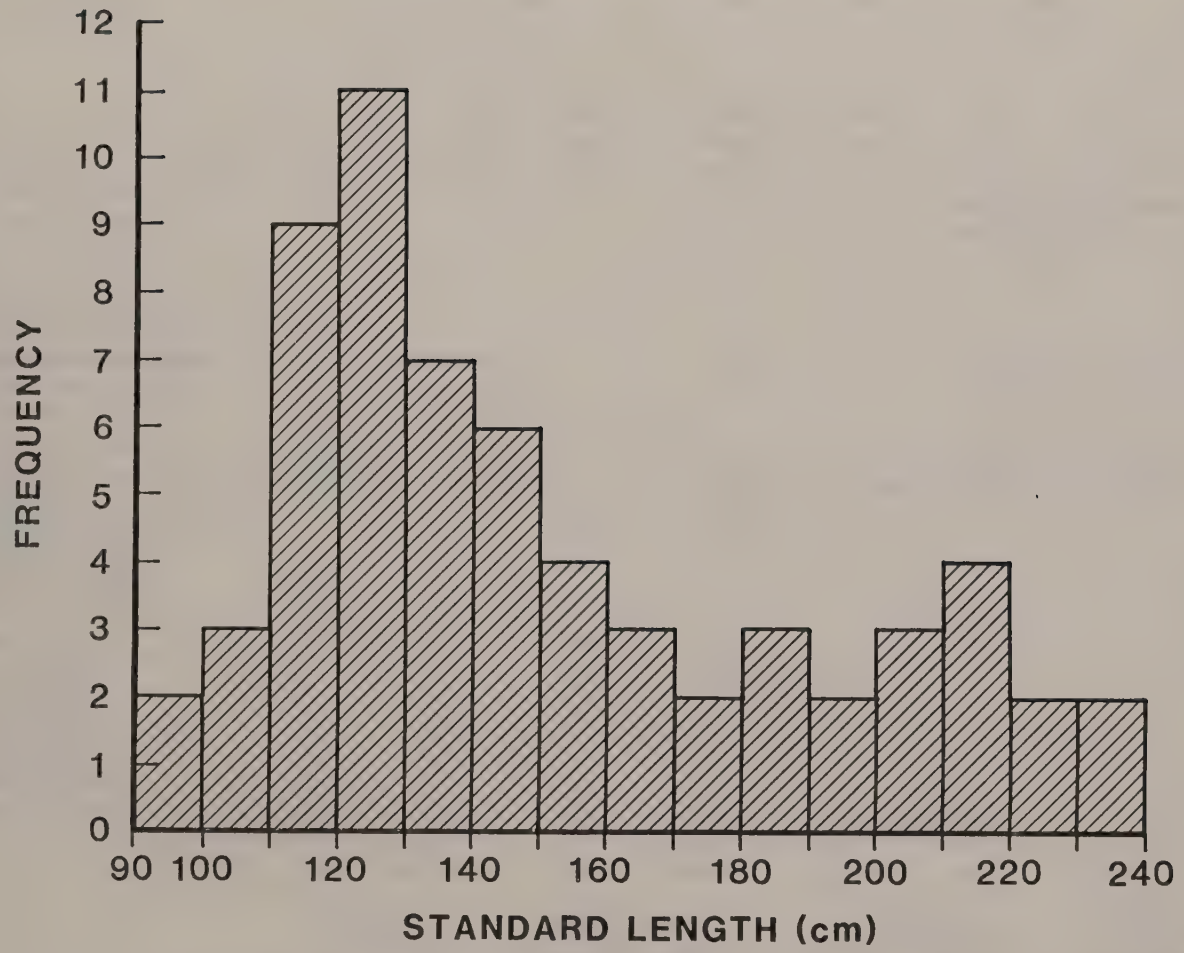


Figure 1. Comparison of standard lengths of male California sea lion carcasses stranded in San Diego County, California, which were examined for stomach contents.

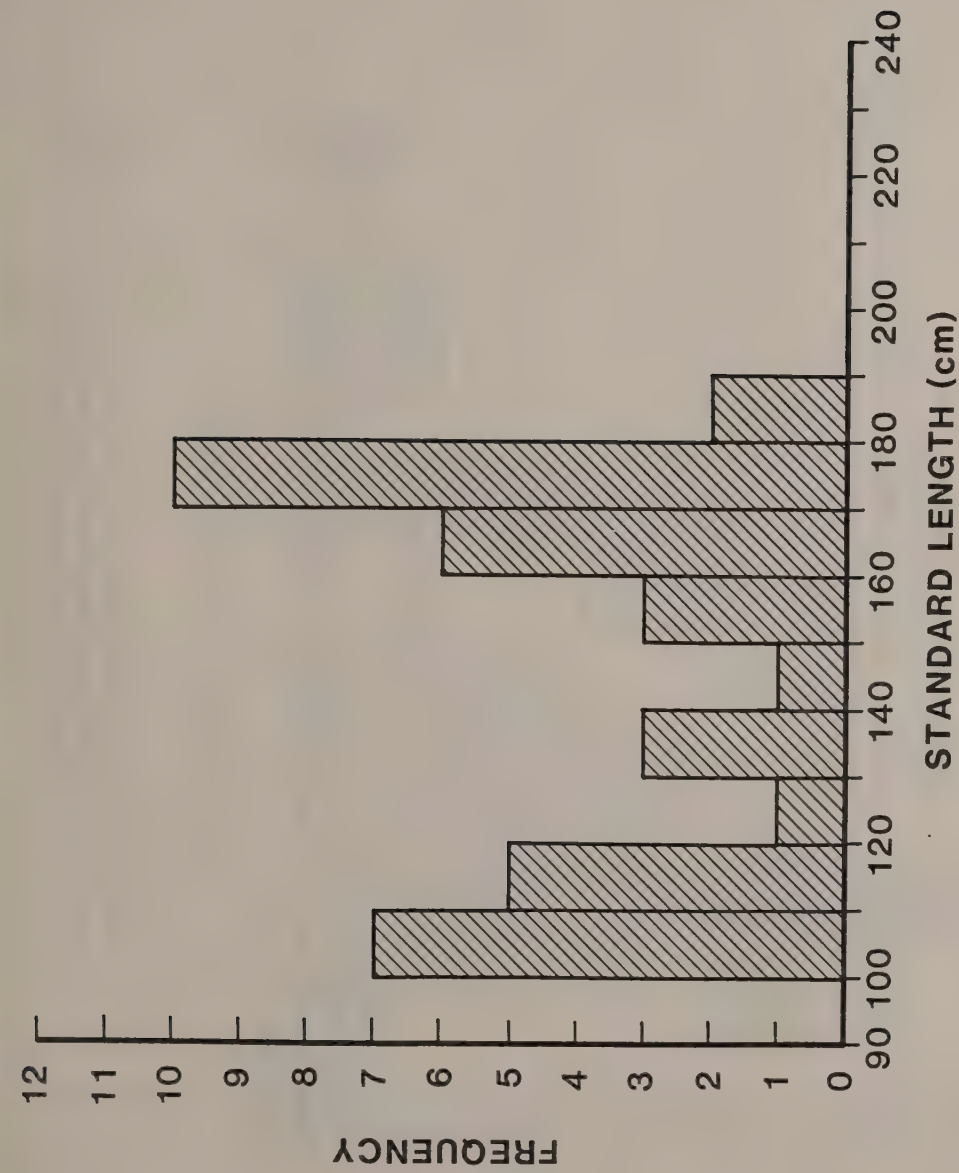


Figure 2. Comparison of standard lengths of female California sea lion carcasses stranded in San Diego County, California, which were examined for stomach contents.

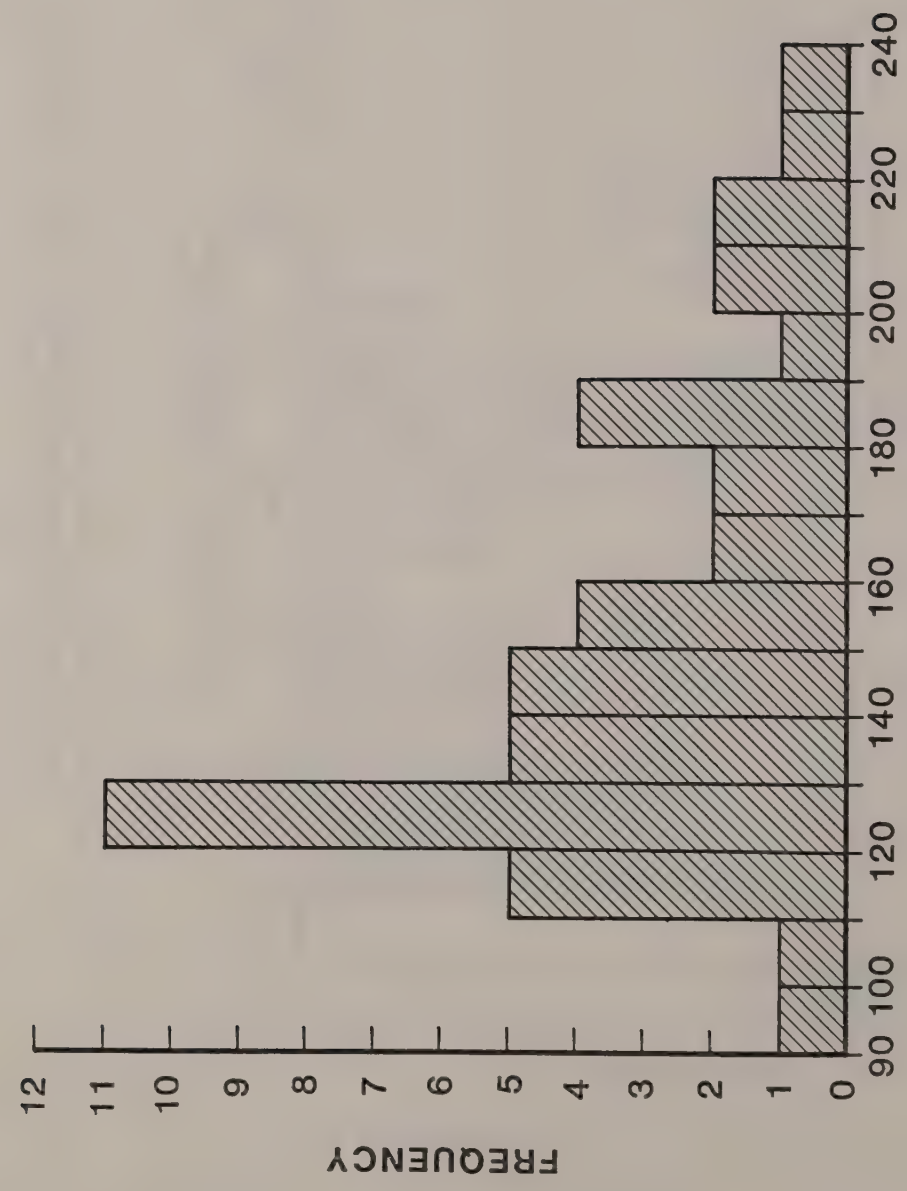


Figure 3. Comparison of standard lengths of male California sea lion carcasses stranded in San Diego County, California, which had stomach contents.

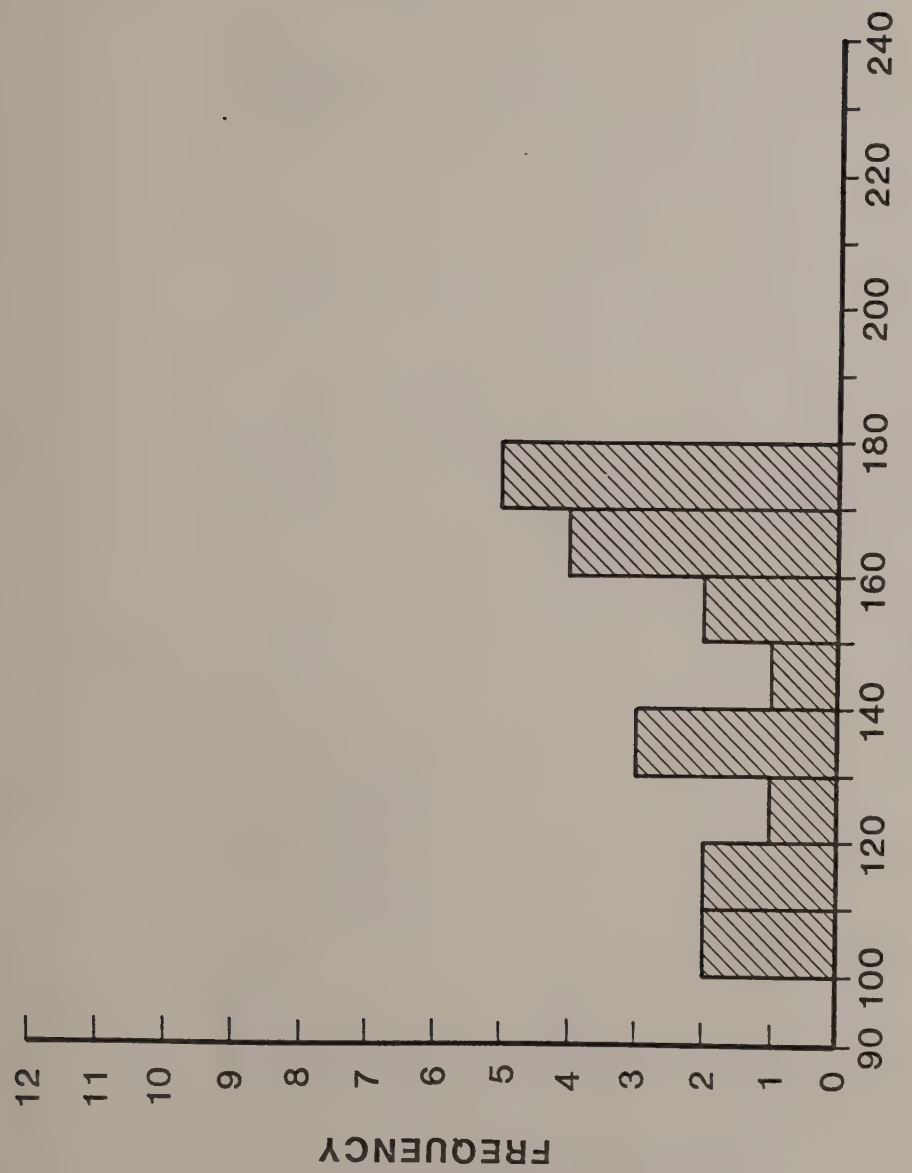


Figure 4. Comparison of standard lengths of female California sea lion carcasses stranded in San Diego County, California, which had stomach contents.

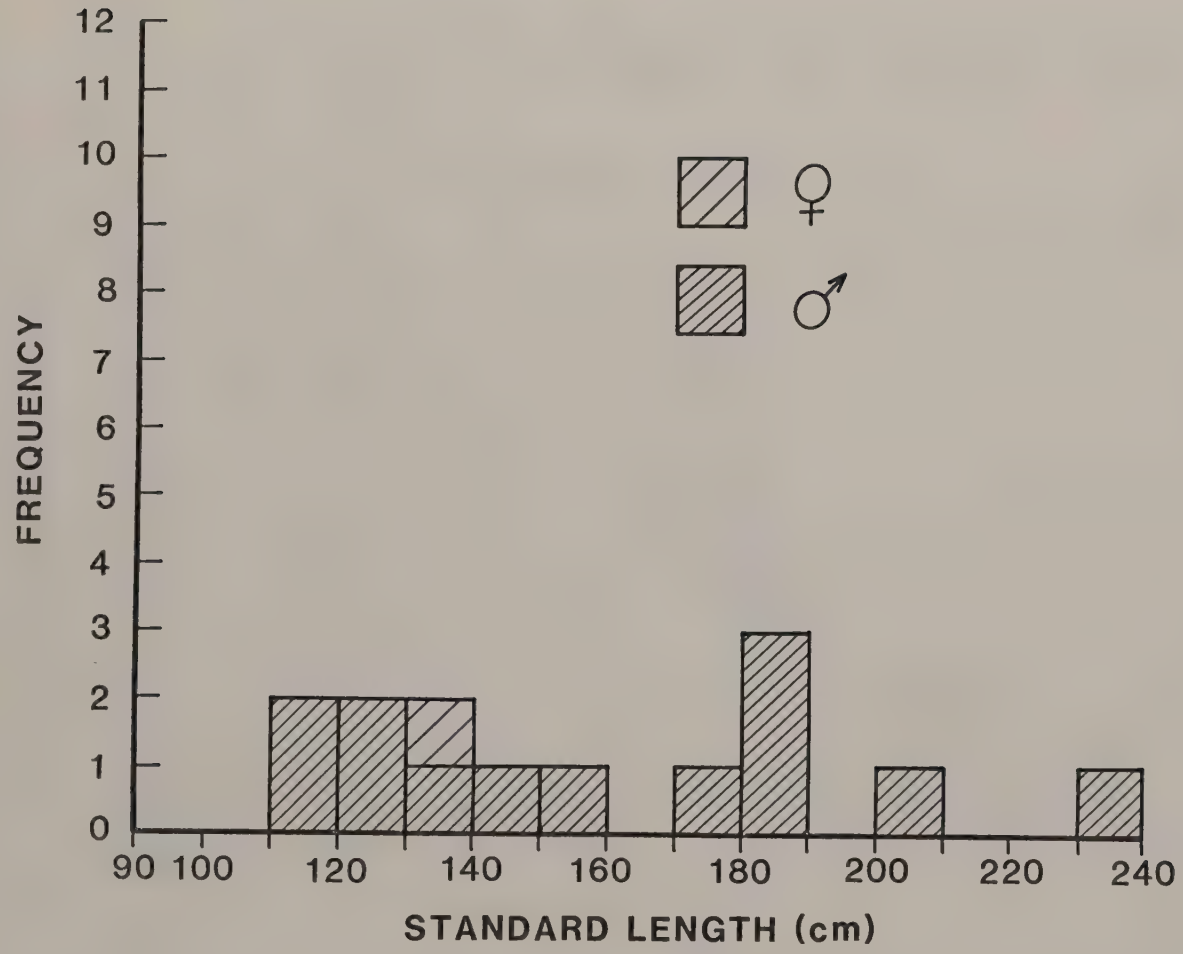
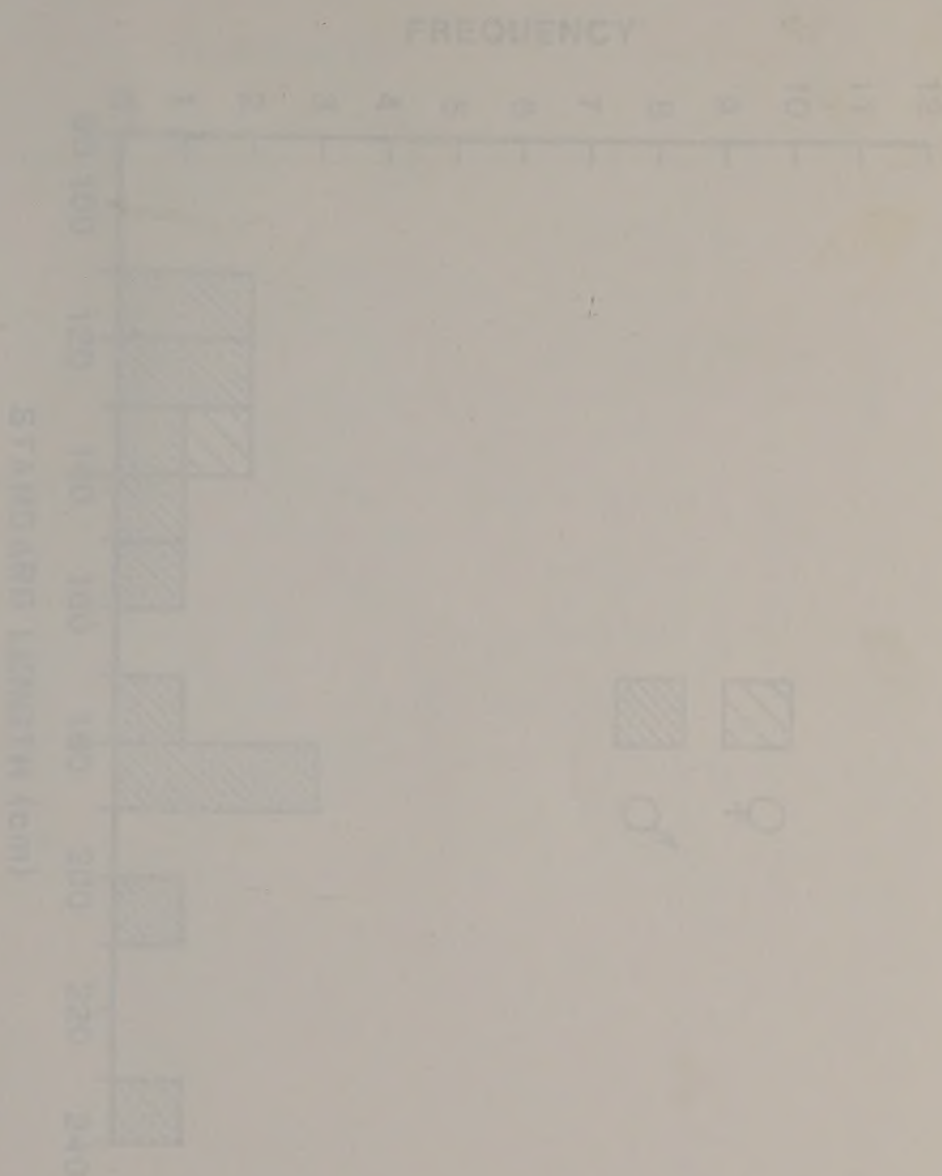


Figure 5. Comparison of standard lengths of California sea lion carcasses with gunshot wounds that stranded in San Diego County, California, which had stomach contents. The sample is composed of thirteen males and one female.


FREQUENCY